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PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvement in Method of Making Synthetic Fibre Paper

I, WILLIAM WARREN TRIGGS, of the firm of Marks & Clerk, of 57/58, Lincoln's Inn Fields, London, W.C.2, a British subject, do hereby declare the nature of this invention (a communication to me from abroad by C. H. DEXTER & SONS, INCORPORATED, a corporation of the State of Connecticut, Windsor Locks, State of Connecticut, United States of America) and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the production of paper which may be employed in industry for various purposes such as for tea bags, as a base for stencils, and for packing and cleaning lenses.

The production of finished paper sheets composed entirely of synthetic, artificially formed fibres and having substantial strength has heretofore been considered impossible. This is probably due to the fact that ordinary or conventional, non-fibrous binders, bonding agents or cements, such as glues, starches or sodium silicate, which are applied in solution form and then dried, do not possess sufficient binding strength to cause the synthetic fibres to entangle or bond together to give the resultant sheet sufficient strength. As a matter of fact, I have actually found that these conventional bonding agents are so lacking in binding strength for this purpose that a synthetic fibre web employing such binders is so weak structurally that it cannot be removed from the paper making wire as a sheet.

Some attempts have been made to prepare paper from a mixture of natural fibres and varying amounts (up to 50%) of an insoluble synthetic fibre, such as cellulose acetate fibre. Papers made of such a fibre mix are then treated with a solvent or heat, or in some cases both, to cause the acetate fibres to coalesce or congeal. This after-treatment, which serves to "fix" the acetate fibre is costly and requires the use of solvents, usually inflammable. Furthermore, it is very difficult to control the "fixing" so that the fibre will not be completely melted or dissolved.

The present invention has for its object a thin, porous, light weight paper of substantial strength which consists essentially of unbeaten, synthetic artificially formed fibres which are matted and held together in sheet paper form with a fibrous cellulosic flock binder composed of microscopical fibrillæ, said synthetic fibres being uniformly distributed throughout the sheet in substantially their original ungelatinous, uncoalesced form but being spaced to present many interstices.

The terms "synthetic fibre" or "synthetic, artificially formed fibre" as employed herein refer only to those fibres which are manufactured by truly synthetic or "reforming" methods wherein a solution of the fibre is extruded through very small orifices (spinnerettes) and then the extruded solution allowed to congeal either in a precipitating bath or by evaporation of the solvent or by temperature changes, thereby forming continuous filaments of any desired diameter which can later be cut into any desired length. The invention is definitely limited to the use of synthetic fibres of the foregoing character and does not contemplate the use of chemically treated or modified natural cellulose fibre, such as nitrated cellulose and the like.

Dimensions of these synthetic fibres useful in the practice of the invention vary in accordance with the type of paper produced. In general, however, fibre lengths of from 1/8 inch to 1 inch and fibre diameter of 12-80 microns, corresponding to 3/4 to 5 denier, are recommended for the type of tissue contemplated.

A great variety of synthetic fibres may be employed for the purpose of the present invention, and I have found that synthetic

fibres such as cellulose acetate, cellulose nitrate, regenerated cellulose from viscose, Vinylite (Registered Trade Mark), Aralac (Registered Trade Mark), and spun glass, may be used in amounts as high as 98% of the basic raw material.

A very important feature of the present invention resides in the use of a specially prepared, fibrous binding or bonding agent capable of causing the synthetic fibres to adhere one to the other to such a degree as to provide sufficient strength in the finished paper sheet. Fibrous binders found useful for the purpose under consideration are derived from two sources:—

When some natural fibres are digested and subsequently washed, there is washed away a material which is made up of very small fibrillæ having dimensions in the magnitude of 0.002 inch long and 0.035 inch wide, and in the paper mat and they pull apart very easily, thereby giving no strength to the paper sheet. The discovery has been made, in accordance with this invention, that fibrillæ may be supplied through the use of the binding flock so that the synthetic fibres may be held together in matted form.

The size of the fibrillæ of the binding flock is microscopical and a comparison of the size of one with the average size of fibres in ordinary papers should be considered.

The following table illustrates a comparison, generally, of average fibre dimensions of the synthetic fibre employed in the invention, the average fibre found in ordinary papers such as tissues, news and writing, as compared to the dimensions of the fine filaments or fibrillæ which are employed in the binding flock for the synthetic fibres.

	Synthetic fibre	*Ordinary fibre*	*Binding flock*
Length	.31 in.	.071 in.	.002 in.
Width, ...	.001 in.	.002 in.	.000035 in.
Projected area ...	.00031 sq. in.	.000142 sq. in.	.000,000,070 sq. in.

which may be reclaimed and used as a binding flock. Some fibres are especially rich in this material. I have found, for instance, that the inner section of the Musa textilis leaf has an abundance of this material.

I have also found that a suitable binding flock can be produced by taking natural fibres and hydrating them in a beater to an extent much beyond the hydration usually employed in highly beaten papers. In fact, the fibres should be beaten to a point where their dimensions approximate those of the natural fibrillæ described in the foregoing paragraph, and where the hydrated cellulose has the colour, appearance and consistency of heavy cream. Under a high-power microscope one can observe that the natural fibres have lost most of their original fibre structure and have been broken down into countless, very short and very fine microscopical filaments. If one studies the surface of natural paper making fibres, such as Musa Textilis, under the electron microscope and compares it with the surface of synthetic fibres, the function of the present binding flock becomes apparent. Under the electron microscope with up to 10,000 diameter magnification the surface of the Musa textilis unbeaten fibre has countless tiny fibrillæ extending from the central fibre. These fibrillæ are responsible for giving the paper formed by these fibres its physical strength. They interlock the main fibres thereby holding them together. The electron microscope shows the synthetic fibre to be absolutely smooth with no fibrillæ extending from its central fibre. For this reason there is no interlocking of the fibres

It will be understood that all the fibre dimensions in the foregoing table are determined by those dimensions appearing in the finished paper, having all the beating necessary for that particular type of paper. It will be observed that the projected fibre area of fibres in the usual papers is more than 2,000 times as large as the projected area of the fibre making up the binding flock and the synthetic fibre projected area is approximately 4,000 times the projected area of the microscopical binding flock fibrillæ.

It should be further understood that in producing these microscopical fibrillæ, not all of the original flock-producing fibres get broken down to the dimensions shown in the table under the term "binding flock". Some fibres will escape complete reduction in spite of long continued beating action. However, substantially all the fibres must be broken down to these small fibrillæ to get good results. Unless at least 90% of the total flock-forming fibre is broken down to within plus or minus 25% of the above fibre dimensions, weak synthetic fibre paper will be formed with great difficulty in handling on the paper machine. Stated differently, at least 90% of the fibrillæ in the flock are .0015 to .0025 inch in length and .000027 to .000044 inch in width.

It is important, in selecting a fibre for the preparation of this type of binding flock, that it be one which will take a good hard heating action and produce hydration rather than pulverization. At the end of the beating the freeness, as registered on the Gurley freeness tester, should be near zero con-

trasted to a freeness of 50 to 500 for usual paper manufacture. Different fibres produce bonding flocks of varying characteristics, but I prefer the flock derivable from such fibres as flax, Manila hemp, coroa, and hemp, although I have made a fair flock from bleached Kraft pulp.

The binding flock may be used in proportions such that the fibrillæ make up 2 to 10% of the finished paper product based on dry weight. Paper containing even as little as 2% by weight of the binding flock possesses sufficient strength to give good machine operation and good use characteristics. Additional strength can be realized if more flock is used and we have found that if 10% of flock is employed a stronger paper results than that prepared from natural fibres of the same length.

The papers of the present invention, being made up of long synthetic fibres are very porous due to the fact that many interstices are left between the fibres. Examination under a powerful microscope discloses that at each crossing of the synthetic fibres there will be a discernable bond caused by the extremely-fine filaments of the binding flock.

It is obvious from the above that many variations in the paper characteristics can be achieved due to the fact that one is able to use any predetermined fibre length, any predetermined fibre width, and various small amounts of binding flock to vary the strength. As pointed out hereinbefore, accurate operating conditions such as these have never been possible when using natural fibres.

The actual paper making steps are quite simple. The stock is made up by first providing a mixing vat to which is added the required amount of water. The desired synthetic fibres of predetermined diameter are then cut to the length desired in the finished paper and added to the vat. After the fibres and water have been added to the vat and well mixed, the desired amount of previously prepared binding flock is added. It should be pointed out that this mixing operation is in no way comparable to the action obtaining in an ordinary paper making beater. The action is purely and simply a mixing one and the fibres remain in substantially their original form. After thorough mixing the stock is fed onto the inclined Fourdrinier wire of the paper making apparatus disclosed in the British patent No. 449,118 to C. H. Dexter & Sons, Incorporated.

Exemplary of the make-up and characteristics of specialty papers manufactured in accordance with the present invention the following may be mentioned:—

Stencil Paper—6-1/4##—Base Weight:—

Fibre length—3/8 to 3/4 inch
Denier—3/4 to 1-1/2
Binding flock—2 to 8%
Bursting strength 3/4 to 5-1/2## per square inch

Tea Bag Paper—8-1/2##—Base Weight:—

Fibre length—3/8 to 1/2 inch
Denier—1/2 to 5
Binding flock—4 to 8%
Bursting strength—3 to 12## per square inch

In connection with that type of paper useful in the making up of tea bags, it might be mentioned that by suitable choice of synthetic fibre a thermoplastic tea bag paper could be made by the process of the invention. In other words, the edges of two superimposed sheets enveloping a charge of tea may be heat-sealed in machinery provided for this purpose to form the finished tea bag. This obviates any after-treatment of natural fibre papers heretofore used for this purpose to render them thermoplastic and heat-sealable.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A thin, porous, light-weight tissue paper of substantial strength comprising essentially unbeaten, synthetic artificially formed fibres matted and held together in sheet paper form with a fibrous cellulosic flock binder composed of microscopical fibrillæ, said synthetic fibres being uniformly distributed throughout the sheet in substantially their original ungelatinous, uncoalesced form but being spaced to present many interstices.

2. A tissue paper according to Claim 1 characterized in that the synthetic fibres have a length of at least 1/8 inch.

3. A tissue paper according to Claim 1 or 2 characterized in that the binder comprises 2 to 10% of the weight of the finished paper.

4. A tissue paper according to any of the preceding claims characterized in that the synthetic fibres form about 98% of the tissue paper.

5. A tissue paper according to any of the preceding claims characterized in that the fibrillæ are obtained by highly hydrating natural fibres in water suspension.

6. A tissue paper according to any of the preceding claims characterized in that the synthetic fibres consist of viscose.

7. A tissue paper according to any of the preceding claims characterized in that the fibrillæ have a length of .0015 to .0025 inch and a width of .000027 to .000044 inch.

8. A tissue paper of substantial strength substantially as hereinbefore defined with reference to the examples.

Dated this 9th day of December, 1946.

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